2001 Trial Transcripts
Part 5

minimum position of the guide vanes, they would close. As we open the guide vanes more and more the curve we find moves farther to the right.

That is more flow is produced by the compressor, but also you'll notice that the pressure is higher. So that if we are operating at a certain flow rate through the compressor right here, for example, let's say this is the flow rate at which we're currently operating the compressor and we need to increase the flow rate to some other value, here, for example, that if we don't change the guide vanes, you will see that the pressure produced by the compressor will fall.

If we wish to control pressure, for example, for the increased flow position, then we would have, let's say we want to control pressure right here, then what we would have to do would be open the guide vanes to produce a characteristic represented by an intermediate curve here where the same pressure would be produced and yet accommodate the higher flow.

Q: Mr. Shinskey, looking at the Honeywell

Page 1347

patents, do they also have an illustration of the affect of inlet guide vanes on the surge point?

A: Yes, they do. In figure six of the Honeywell patents there is a representation, using similar coordinates as we have here, showing the relationship between the surge area and the guide vane positions.

So here we have compression ratio shown again on the left axis of the screen here and we have inlet air flow shown along the base and that is a volume metric flow which also was the flow coordinate on the last screen.

Now, the curves which were shown on the previous screen, only a portion of these curves is shown here, just a portion approaching the surge point.

So, for example, in figure six, line 146 B would represent the relationship between compression ratio and flow for a guide vane angle of 70 degrees.

Now, the guide vane angle of 70 degrees, that's 70 degrees closed rather than opened. When the guide vane is almost fully opened the angle is zero degrees, so don't be

Page 1348

confused with the fact that we get more flow with a smaller angle. We're talking about angled closed, not opened.

And then again here is the surge area corresponding to that particular guide vane position, and as we go to a more open guide vane position, 35 degrees in this case, then we see that the surge area has moved from here up to here, and the surge point at the same value of temperature, the three parallel curves that we have here are different temperatures, so we'll just look at the center of the three curves.

So we would be moving from 70 degrees guide vane angle to 35 degrees guide vane angle and you see that the surge point which is in the center curve, the mean temperature in each case, moves to a higher flow rate and also to a higher compression ratio.

Q: If you could, please, explain the connection between what we see here and why a surge control system would adjust the set point based on inlet guide vane position?

A: Let's suppose that we were operating with a guide vane angle 35 degrees, and if this is our

Page 1349

surge point, our control line is normally giving a safe margin from surge point.

So if surge would be here, for example, our control line is positioned here. So this gives us this safety margin of five percent or something like that.

And this then would be the flow at which we would control our surge controller would be set. This would represent the set point of the surge controller for the 35 degree guide vane angle.

Now, suppose if at some later time in the operation the guide vanes were closed to the 70 degree angle, and our — we were still operating with the set point corresponding to the more open, or 35 degree angle. Well, when the flow came down to this point, we would exhaust compressed air when we really did not need to exhaust compressed air until the flow came down to this point here and so you see that the compressor operates more efficiently if the set point for the flow controller which is protecting against surge is adjusted as a function as a position of inlet guide vane.

Page 1350

Q: And do the Honeywell patents show how to adjust the set point based on guide vane positioning?

A: Yes, they do. That is shown in the functional diagram on figure four, which is directly above figure six on the second page of the patents.

In this figure we have an input signal from the guide vane appearing right here this is the ITP position.

Q: Mr. Shinskey, let me interrupt you, we have a simply extract for figure four that might be a little easier to follow. If we could show our 21, I think it is. If you could explain what this shows?

A: This is an extract. What the extract does is eliminate in the lines which are not pertinent to the surge control system as we are describing it now.

The signal coming in at the upper left of the screen, which is number 90 on the patent, this is the position of the vanes.

And the next to the right where the signal is there as an input expresses the

Page 1351

relationship between the desired flow and the angle of the guide vanes.

And the desired flow is shown in terms of the pressure drop across the flow meter divided by the pressure in the — the discharge pressure — the total pressure of the compressor.

This is your flow related parameter. I'm simply going to reduce that flow. I happen to know it's a representation of volume metric flow cubic feet per minute.

This functional block or function generator as it is called in the patent takes the measure of the guide vane position, and for any guide vane position, converts that to a corresponding set point for the flow controller, the surge controller.

Then it produces the output signal, then representing the desired value for flow and so this then becomes our set point for flow.

And again, as in the other control loop you saw earlier, we have a comparator where the set point is compared against the sensed value of flow this is the measured or sensed value of our flow related parameter. The error signal is

Page 1352

produced.

And then the error signal is sent to the integral and proportional controllers.

MR. HERRINGTON: Stephanie, could you save this visual?

BY MR. HERRINGTON:

Q: Mr. Shinskey, I would like to compare what you've shown here to what the APS 3200 does. And if I could, please, ask you, does the APS 3200 adjust its set point as a function of inlet guide vane position?

A: No, it does not. The APS 3200 adjust its set point as a function of air temperature.

Q: If we could please have chart 32.

Mr. Shinskey, if you could identify what this shows and relate it to what we've marked previously as Defendant's Exhibit 26?

A: Yes. This is figure 12a out of the specification for the ECB block, the ECB requirement specification. Figure 12a describes the surge control system which uses the proportional integral controller to modulate the bleed control valve.

This particular visual has been

Page 1353

simplified somewhat in that the complications that appear in the actual figure 12a have been replaced by just a block that says PI controller to avoid distraction.

In this diagram, we have temperature rather than inlet guide vane positions used to set the set point.

So here we have temperature which is used. And again, it's done in a similar way. There is a function block, the measured temperature in this function block and it's converted into a surge set point. Again, a very similar functionality.

In the table that appears under this function block, it simply points out four different values of temperature and the corresponding set point associated with those. But the function block contains the complete set of information from the maximum to the minimum temperature.

The output of the function block is identified as the surge set point.

And it is compared, here is our comparator again, it is compared with the surge

Page 1354

controlled variable, which in the case of the APS 3200, we have called DELPQP. This is not volume metric flow cubic feet per minute such as used in the patent. It's a different variable.

MR. HERRINGTON: Your Honor, before we move on, could I either ask for a short break or maybe just a stand up, and/or to stand up in the seats? It's hot on a Friday afternoon.

Could I ask for an opportunity for a very short break or maybe an opportunity for people to stand up and stretch a little bit?

THE COURT: Are you okay? Do you want to stand? You're fine. They're fine.

MR. HERRINGTON: Very good, Your Honor.

BY MR. HERRINGTON:

Q: Mr. Shinskey, I think we have a picture of how the APS 3200 adjust its set point side-by-side with what the patent shows, and if you could, please.

Mr. Shinskey I think you need to put the pen back and then it will change screens.

If you could please explain what this shows?

Page 1355

A: Right. The left-hand figure here is an extraction from the patent and it shows inlet guide vanes being used to set the set point of the surge controller and you can see inlet guide vanes appearing as the input signal to the function block and the flow related parameter as the output from the function block.

On the right-hand side we show a similar function block used in the APS 3200, but it has a temperature input rather than guide vane input. But it's output has the same affect on the control system if in that it's the set point for the surge controller.

Q: I think we have another visual that shows the effect of the difference in how the set point is adjusted. If you could please show chart 42.

Mr. Shinskey, if you could walk us through this exhibit?

A: This is a repeat of the two drawings that we had earlier individually. And again, up in the upper left, we have the IGV is the input to the function block which sets the set point to the comparator to the proportional and integral controller for the patents.

Page 1356

And to the right we have instead our temperature input, which enters the function block and sets the set point to the comparator for the APS 3200 surge control system.

MR. HERRINGTON: Stephanie, if you could save this chart.

BY MR. HERRINGTON:

Q: Mr. Shinskey, let's discuss how and why the APS 3200 uses inlet guide vane position at all, if you could please explain that?

A: Well, we talked briefly about the — a surge variable which is used by the APS 3200 not being a flow measurement. There is no flow meter in the APS 3200 used for surge control. The measurable variable used for surge control in the APS 3200 is a combination of the differential pressure taken across the diffuser, which is an integral part of the compressor and the pressure that is measured at the discharge of the compressor.

And this produces a unique measurement. It has the property of representing surge conditions for a variety of guide vane positions without having to move the set point.

Page 1357

In other words, the value of this DELPQP parameter and its approach to the surge point is not a surge of the guide vane position because of the pecuniary nature of this parameter.

However, it has some undesirable features with it. Because it is not a simple flow measurement, it does not increase proportional to flow across the entire operating range. The DELPQP measurement is really a composite measurement. It includes compression ratio along with flow.

The diffuser in the compressor takes the flow from the spinning blades of the impeller and directs that into the scroll which collects the compressed air from all around the periphery and sends it of course to the aircraft.

This diffuser is a set of vanes which converts velocity into pressure rise. And as much as half the pressure rise that's created in the compressor is created in the diffuser.

When we measure pressure across the diffuser, we'll measure, for example, in the order of ten to 7 pounds per square inch pressure rise.

Now, what happens if we increase

Page 1358

flow to some extreme value in a compressor, the pressure that is produced at the discharge of the compressor all of a sudden falls very sharply.

And we find that at extremely high flow rates, our DELPQP signal starts falling instead of rising continuously as it would if it were a simple control valve signal.

If it were to fall low enough to have the same value that it did at low flow conditions where we were controlling at a surge set point, then it would open the bleed valve when the bleed valve did not need to be open because we have more than enough flow to keep out of surge.

So to protect the bleed valve from opening at these very high flow rates when there is no need for the bleed valve to open, we needed to test to see whether we were on the right side of this double valued curve or on the left side.

Q: Mr. Shinskey, why don't we sho the double valued curve and fir we'll show what an] Real engineering charts looks like and then we'll show an illustration of it.

Why don't we first show chart 49.

A: Now, this chart doesn't have a smooth

Page 1359

curve drawn through it. It looks like kind of a pattern of gun shots, for example at a target. I will try to connect the dots, so to speak, to make it look like a more coherent curve.

What we're seeing here is DELPQP and I will write it as such. That's your surge parameter which is being controlled in the APS 3200.

And this is plotted against flow. Now, if we connected all these dots together we will have a curve that rises as we increase flow very, very sharply and up in this region where DELPQP reaches approximately 0.5, increasing flow causes it to fall.

So it turns around in this area, and if we extrapolate the data, we can see that it might fall down into the region where our set point would be located.

The set point for surge for the APS 3200 is located between approximately .2 two and .24 as a function of temperature.

So this would be the set point range for the APS 3200. So we normally control here.

Now if, an extreme value of flow

Page 1360

came which caused DELPQP to fall back into the set point range over here, again, the bleed valve would be opened unnecessarily.

To avoid that, Sundstrand has put in some calculations to determine whether we are on the right side or the left side of the peak value.

Q: Why don't we show our illustration of what we were calling the double solution curve. Chart 49.

A: This is a simplification of course of that pattern that you saw on the previous slide, but it gives all of the important features we have shown for values of DELPQP that are too low below the set point we can encounter surge. So our set point is set in the region where we will protect the compressor from surge.

Now, if the demand for flow from the aircraft increases beyond the surge limit, then the flow increases above the set point and there is no need to exhaust air using the bleed control valve. The bleed control valve would close and flow would be in this region here.

Now, if flow were to get this high

Page 1361

so that DELPQP is well above the surge set point, we don't need that control system at all anymore. The bleed valve is already closed, so we built in some protective features to be sure that the surge control system will not, in fact, move the bleed valve should we ever get over here.

And that has two protections, two tests so to speak. And the first test executes when DELPQP reaches 0.35.

Once DELPQP rises that the value would reach the high flow cutoff point and the system goes into high flow mode.

That would be enough if — as long as the flow never causes DELPQP to fall back below 0.35 again, if it did, over in the region here, you can see that DELPQP less than .35 would then switch back to low flow.

So to prevent that from happening there is a second calculation or test where we use guide vanes to estimate the compression ratio at which we reach what we call choked flow and the compressor cannot deliver anymore flow.

Choked flow occurs on the right side of the peak. So over on this right side of the

Page 1362

peak we go through the IGV compression ratio test to determine if we're in the high flow mode. So the IGV compression ratio test acts as a backup to high flow cutoff test.

Q: Mr. Shinskey, are there other variables in this compression ratio test?

A: I believe temperature is also another variable in this IGV. And let me just add to it, IGV temperature compression ratio test.

Q: Why don't we look at what we called the logic of the 3200 surge control system that deals with this double solution problem.

Before I do that, maybe if you could, maybe it would help to illustrate, compare what is happening to how say a speedometer on the car and how that increases in relation to speed, could you give us a picture of what is going on here?

A: If we had a speedometer that kept increasing as we increased the speed of the car and then turned a corner and went back down as we increased the speed even further, if we put a cruise control system on that, once we came back to the set point on the cruise control, it would

Page 1363

work backwards.

If we increased the speed of the car, the indicated speed would fall and the controller would say the speed is falling below set point, we need to put more fuel into the engine. See we cannot allow reverse or double solution variable to exist in the context of a closed control loop.

Q: Why don't we look at the control logic that deals with this problem.

Can we show chart 39. And Mr. Shinskey, let me ask you first, does this correspond to anything in the ECB spec which is Defendants' Exhibit 26?

A: Yes, it does. This would be Figure 12D in the ECB specification. I don't see the figure at the bottom of the page, but that's where it's taken from.

Q: If you could, please explain what we see here?

A: Well, what we see here is the logic behind the high flow testing. And the first element of logic or the first test that is performed is this test here, DELPQP greater than

Page 1364

0.35 and that occurs right here.

If DELPQP should rise to a value greater than 0.35, then this device, which is a logical operator, would produce a value of one which would equal high flow.

And normally, of course, when we're in low flow, that is when DELPQP is less than 0.35, this would have a logical value of zero.

And as I said, that's the first test, that would be the first thing that would happen which would produce a logical output of one to the bleed select as opposed to the low flow which is represented by a logical value of zero.

Now, if we pass the peak, then the compression ratio test comes into play. And the compression ratio test is performed here.

The temperature of the air and the position of the guide vane goes to — into a very complicated calculation here to determine what the compression ratio would be if the compressor were, in fact, operating in the choked flow mode.

This goes into another logical operated device where the calculated value of compression ratio corresponding to choked flow is

Page 1365

compared against the actual compression ratio.

And if the actual compression ratio — these are — let me back up a little bit. This is the discharge pressure, and this is the inlet pressure to the compressor. So we're dividing one by the other.

And the ratio of these is the compression ratio.

So if the actual value of the compression ratio at this point in time now were to be lower than the calculated value corresponding to choked flow, then this will send out a one, it says this statement is true. And therefore, we are in choked flow. So one over here corresponds to choked flow.

Now, where these two logical signals combined over here, they're combined in the device known as an or gate. This is a very, very simple concept. It means that if one of the inputs is true, or the other input is true, the output is true.

So if the high flow test performed by DELPQP being greater than .35 is true, then it sends out a bleed select value of one saying we're high flow.

Page 1366

Or if the compression ratio test is true, indicating we're in choked flow, the or gate again sends out a high flow signal of one which would then keep the system in the high flow mode regardless of whether DELPQP had fallen below 0.35 on the right side of the curve.

MR. HERRINGTON: I have just a couple of minutes to address one issue, and then I think it would be a natural breaking point.

THE COURT: Okay.

BY MR. HERRINGTON:

Q: Mr. Shinskey, if we could please put on chart 41.

Could you put on chart 35. There was some discussion in earlier testimony about whether the tests that uses IGV position would ever switch the system from high flow to low flow or not. Could you please address that?

A: Yes. If we look at the progression of flow, we see that on an increase in flow, first what will happen is that the flow will begin to increase above the surge point, the set point of the surge controller.

Page 1367

As the flow increases above the set point of the surge controller, then the surge controller closes the bleed valve because the flow is already higher than the set point and no more flow is required.

As the flow continues to increase, then we reach the high flow cut off which is trigger by the DELPQP greater than 0.35.

Q: Let me ask you this. If DELPQP is greater than .35, does that use the inlet guide vane position at all?

A: No. What that does is it transfers the system from the low flow to the high flow mode. And in the high flow mode the bleed valve is closed, but it's already closed before we get there. It's closed because while operating in the yellow region here, the surge controller has already closed the bleed valve.

We reach the high flow cut off when DELPQP is greater than .35, it gives us a logical one from your or gate which locks the bleed valve control valve closed and interlocks the proportional integral controller.

Q: What effect, if any, would the test that

Page 1368

does use the inlet guide vane position have within the system?

A: The test that uses inlet guide vane position only comes into play between the peak and the equivalent value for high flow cut off on the right-hand side of the curve.

So in this region somewhere, if it were to come into play, the IGV temperature compression ratio test would produce a logical value of one which would then pass through the or gate and if DELPQP were to fall below .35, the test using IGV position, compression ratio and so forth, would serve to hold the system in high flow, not switch it between high flow and low flow, but simply hold it in lie flow.

Then as we return to lower flow, you will see that — let's say that we leave in region that I have circled in red the choked flow position no longer prevails, but because DELPQP is greater than .35, we have a logical one coming from the DELPQP test, so again we remain in the high flow condition even after the test using IGV position fails that produces a zero rather than an one.

Page 1369

And then coming back down as we the DELPQP falls below .35, we unlock the bleed valve, we reconnect the proportional and integral controller to the bleed valve, but again we're not opening the bleed valve, it's still closed because our flow is still well above the surge control set point.

MR. HERRINGTON: Thank you, Mr. Shinskey. This would probably be a good place to stop.

THE COURT: All right. Ladies and gentlemen of the jury, we've come to the end of our day and end of our week. And I'm going to wish you a safe journey home, but I want to remind you that you must not discuss this case, certainly among yourselves or with anyone. Do not listen to any news accounts, read any news accounts, do any research on it. Please above all keep an open mind.

Have a safe journey I. Have a good weekend.

(Jury leaving the courtroom at 4:36 p.m.)

THE COURT: Counsel, the only

Page 1370

thoughts on my mind were two questions, how are we making out with the jury instructions, and secondly, the verdict sheet?

MR. KRUPKA: Your Honor, the jury instructions, I think that's in your court right now.

THE COURT: Is it back to me?

MR. KRUPKA: I think it's back to you now, Your Honor. I think you have got everything that we've got. There may be some additional ones that we want to propose to clean up some issues, but —

THE COURT: Fundamentally it's in my court.

MR. ZIEGLER: What was submitted Monday morning, Your Honor, isolated the two current proposals on each side on the issues of willfulness and doctrine of equivalents.

MR. KRUPKA: Your Honor, just to give you a final update on that, I have proposed to Mr. Ziegler an expanded instruction on the definition of comprising. He hasn't gotten back to me on it. I know he's been busy. I don't think it's controversial. We will get that in to

Page 1371

you next week.

THE COURT: Okay. See you back here on Monday.

(Court recessed at 4:40 p.m.)

Page 1372

INDEX

Page 1373

State of Delaware)
New Castle County)

CERTIFICATE OF REPORTER

I, Dale C. Hawkins, Registered Professional Reporter and Notary Public, do hereby certify that the foregoing record is a true and accurate transcript of my stenographic notes taken on February 9, 2001, in the above-captioned matter.

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 9th day of February, 2001, at Wilmington.

Dale C. Hawkins, RPR

In The Matter Of:

Honeywell International Inc., et al. v.
Hamilton Sundstrand

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Hawkins Reporting Service
715 N. King Street
Wilmington, DE 19801
(302) 658-6697 FAX: (302) 658-8418

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Page 1374

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

HONEYWELL INTERNATIONAL, INC.,)
and HONEYWELL INTELLECTUAL) VOLUME 6
PROPERTIES, INC.,)
Plaintiffs,)
v.) No. 99-CV-309
HAMILTON SUNDSTRAND CORPORATION,)
Defendant.)

Wilmington, Delaware
February 12, 2001
9:00 a.m.

BEFORE: HONORABLE GREGORY M. SLEET

APPEARANCES:
MELANIE SHARP, ESQ.
Young, Conaway, Stargatt & Taylor
-and-
ROBERT KRUPKA, ESQ.
JONATHAN PUTNAM, ESQ.
LEE ANN STEVENSON, ESQ.
VICKIE REZNIK, ESQ.
TODD SCHULMAN, ESQ.
Kirkland & Ellis
(New York, New York)
for the Plaintiff

Page 1375

APPEARANCES, CONTINUED:
RICHARD D. KIRK, ESQ.
Morris, James, Hitchens & Williams
-and-
RICHARD F. ZIEGLER, ESQ.
DAVID HERRINGTON, ESQ.
LARRY FRIEDMAN, ESQ.
JUSTIN ANAND, ESQ.
STEVEN S. SPARLING, ESQ.
JOSHUA RAWSON, ESQ.
G. CHRISTOPHER BRAIDWOOD, ESQ.
Cleary, Gottlieb, Steen & Hamilton
(New York, New York)
for the Defendant

Page 1376

THE COURT: Be seated, please. Counsel, I'm in receipt of a letter dated yesterday concerning some disputes over some deposition designations.

It's the last thing I would have expected and wanted to see coming into my office this morning.

Counsel, you have exhausted the last reservoir this Court has to offer you. I'll offer you this, you work this out or we're going to have a mistrial. Okay?

(A brief recess was taken.)

THE COURT: Good morning again, counsel. Are we ready to have our jury brought in?

MR. HERRINGTON: Can Mr. Shinskey come on up or wait until the jury comes in?

THE COURT: Why doesn't he wait. Good Monday morning, ladies and gentlemen. I trust that you had a restful weekend, hopefully. I tried.

In light of the late start this morning, we'll work straight through until 11:30 and take our morning break at 11:30 instead of

Page 1377

11:00. Is that acceptable?

Thank you very much. Counsel, we're ready to go.

MR. HERRINGTON: Your Honor, we ask Mr. Shinskey to resume the witness stand. Mr. Shinskey, please resume the stand.

THE CLERK: Mr. Shinskey, having been previously sworn, you may take the stand.

DIRECT EXAMINATION

BY MR. HERRINGTON:

Q: Good morning, Mr. Shinskey.

A: Good morning.

Q: On Friday, we talked about inlet guide vanes being used with compressors. I just want to ask you a quick question about that.

I believe Mr. Muller said in his testimony that adjusting the position of inlet guide vanes is the only way to effect flow through the compressor. In your understanding, is that correct?

A: I would not agree with that, no. In fact if that were the case, opening the bleed valve would not change the flow through the compressor, and therefore, would not be useful in controlling

Page 1378

surge.

Additionally, the ducting from the compressor to the aircraft goes to several places, the main engine starts, and also the air conditioning system. Each one of those consumers of compressed air has valves, and when those valves open, of course inflow through the compressor increases.

When they close, the flow through the compressor decreases, that's what's called the load on the system.

And in this respect the bleed valve acts as kind of an artificial load to apply a load equivalent to what the aircraft would be drawing if the aircraft was not drawing enough to keep the compressor out of surge.

Q: Now, before we stopped on Friday, you were explaining the difference between adjusting the set point of a surge control system based on inlet guide vane position and what the APS 3200 does, which is adjusting the set point based on temperature.

If we could please have chart 42. Mr. Shinskey, can you briefly

Page 1379

explain —

THE COURT: Hold on a second.

MR. PUTNAM: What exhibit number is that?

MR. HERRINGTON: I'm not sure which one it is in this book.

MR. PUTNAM: I'll just look at it on there. Thank you.

MR. HERRINGTON: Okay.

MR. ZIEGLER: Your Honor, it's somewhat faint on the screen. I wonder if there is some lights that can be turned off.

THE COURT: Ms. Preston, can you adjust the lights? Members of the jury, how is your sight on this? Can you see? The jury seems to be okay. Maybe one bank. Is that a little better? Okay.

BY MR. HERRINGTON:

Q: Mr. Shinskey, if it would help to approach the smart board, please feel free, but if you could briefly walk us through — if you could please walk us through what this shows and from the point of view of a controls engineer what the difference is between these two diagrams?

Page 1380

A: Yes. On the left-hand side we have an excerpt from figure four of the patent, which shows the functional relationship between guide vane position and the set point of the surge controller.

And it shows a guide vane input to the left and the output of this function block, functional device is the set point for the surge controller.

And that enters the comparator where it's compared against the flow related part and the air goes on to the proportional plus integral controller.

And this means that for any given position of the guide vane, there will be a corresponding value as a set point for the surge controller.

In the case of the APS 3200, that functionality is replaced by a temperature input.

So in the 3200, we have another function block similar to the function block in the patent, but temperature is the input variable.

And again, this generates the set

Page 1381

point as the output of the function block, the set point goes to the comparator which is just like the comparator in the patent, and then to proportional integral controls like the proceed proportional integral controls in the patent.

So the temperature input is not additional to guide vane input, it substitutes for guide vane input.

And in this case, if there is a given temperature, for example, 59 degrees or whatever the temperature happens to be, that produces a set point of, for example, .214, or whatever is the relationship, I can't quite see because of the numbers are so small on the screen.

So if the aircraft is sitting on the tarmac at a certain temperature, then a certain set point is produced and sent to the controller.

Now, the guide vanes can move all over as demanded by the control system in the aircraft and still that will have no affect on this set point. This set point will remain at whatever value is programed into it as a function of the existing temperature on the field.

So, again, the temperature is a

Page 1382

substitute for IGV position. It's not added over and above, it is separate and replaces the IGV position in functionality of the control system.

Q: Thank you.

Why don't we talk now about the reason why IGV position is used at all in the APS 3200. And if you could, please, show chart 35.

Mr. Shinskey, if you could explain what we're seeing here?

A: I believe we covered some of this ground on Friday, but the idea here is that the particular variable which is used, which is controlled in the surge control system for the APS 3200, is DELPQP, which is also called the "static pressure parameter."

And because this only includes flow as a component and flow is not the only variable which it reflects, we discover that at very high flow rates because the compression ratio of the compressor falls at high flow rates, that at very high flow rates this DELPQP measurement falls instead of rising as flow signal would.

And therefore the possibility exists that DELPQP could fall into a region and

Page 1383

approaching the set point of the surge controller at very high flow rates.

Under this condition, we're so far away from surge that we do not need to open the surge valve, and so the surge controller has no function in this operating range. And therefore to prevent the surge controller from operating the bleed valve in this range of flows where we know it's not required we have logic, which disconnects the bleed valve from the surge controller, and closes the bleed valve to exhaust, fully open to the aircraft.

Again, its only purpose is to protect against this possibility and it's caused based on the unique characteristic of the DELPQP measurement as a function of flow.

Q: Let me ask you, Mr. Shinskey, does the Honeywell patent, the '893 and '194 patent, have any discussion at all of a parameter that behaves like this?

A: There is no discussion in the patents on a double value function. There is no discussion on a high flow versus a low-flow mode of operation, or any means used to protect against

Page 1384

the double valued function interfering with surge control.

Q: Why don't we take a look at what we call the logic in the APS 3200 that was developed to deal with this situation.

If we could have chart 39, please. And Mr. Shinskey, let me ask you first of all, is this a reprint of figure 12a from the ECB specification from the 3200 which is the exhibit?

A: Yes, it is a reprint of figure 12b.

Q: 12b, I'm sorry. You're correct.

If you could please briefly identify the two tests that are used here for dealing with this double solution parameter issue?

A: The first test I'll put a number one here. The first test is whether DELPQP is greater than 0.35. If DELPQP is greater than 0.35, then a logical value of one, and I'll write here "logical one" so you'll know what I mean, logical value of one which means true is sent to the bleed select system to lock out, or lock closed to exhaust the bleed surge control valve, and disconnect the PI controller from operating that valve. That's the

Page 1385

first test.

Now, if the first test should fail because we have proceeded so far into the high flow region that DELPQP comes back down below .35, if that event were ever to happen, we have a second test, a backup test to protect against the bleed valve being operated by the surge controller.

And that second test is very complicated. It involves calculating what the compression ratio would be if we ever reached that condition.

And we measure the compression ratio and compare it to the compression ratio corresponding to that very high flow condition.

If the compression ratio is less than calculated which would correspond to that high flow condition, then this device puts out a logical one, which then goes through this gate.

Now this, what we call an or gate, which will produce a logical one or true value in its output if either input has a value of one or true.

Now, you may have heard this called

Page 1386

a comparator. This is not a comparator. The or gate will produce a value of one if either input is one regardless of what the other input is, so the two inputs are not compared at all.

Q: Mr. Shinskey, let me just stop you. You say you may have heard this referred to, I'm not sure it was entirely clear from Mr. Muller's testimony, but if he was referring to this or gate as a comparator, from your understanding as an engineer, is that correct?

A: That's not correct, no.

Q: All right. Let's show chart 35, briefly.

If you can explain on chart 35, is the same logic that we just saw in the double solution curve on the right?

A: Yes.

Q: I want to ask you, I believe Mr. Muller said that the test that uses inlet guide vane position sometimes switches the value of bleed select from zero to one or one to zero, in other words, sometimes switches the system between high flow and low flow.

In your understanding, is that

Page 1387

correct?

A: No, that's not correct. If we follow the natural progression as flow increases, as flow goes above the set point of the surge controller, which is in this region here, then, of course, the surge controller will close the bleed valve through proportional integral action.

Then as flow continues higher than that, eventually DELPQP reaches this high-flow cutoff point which is this 0.35, at which point the bleed valve has already been closed by the controller, but now the bleed valve is locked close with a constant voltage signal and the controller is disconnected from the bleed valve. Further increasing in flow will bring us up into this area over here.

After the peak has been crossed is where this second or backup test comes into play. It will not function until after the peak is crossed because the falling DELPQP signal on the far side is indicative of a lower compression ratio.

So when the come pressure ratio suddenly starts falling sharply, it indicates

Page 1388

we're over here. And then this test will produce a logical value of one.

So it never switches between high

flow and low flow, it only would stay in the high-flow mode or retain the high-flow mode in the event that DELPQP signal test happened to fail.

Q: When you say it would not switch the system between high flow and low flow, what are you referring to?

A: I'm referring to the test in which the IGV position is used will not switch between high flow and low flow. The high flow and low flow transfer takes place over here by virtue of the DELPQP being greater than or less than .35.

Q: Let's talk about the effect of the switch between high flow and low flow, regardless of what causes the switch, but the effect of the switch between high flow and low flow. And if we could have chart 41, please.

Mr. Shinskey, could you explain briefly what this is showing?

A: Yes. Over on the left side of the screen here, we have the signal coming from the P & I controller. Let me just label that as such. This

Page 1389

signal then passes through some limits and then will continue to go to the bleed valve and operate the bleed valve, as long as the bleed select, which signal comes in here, has a value of zero.

Now, the switch that's shown right here, let me circle this switch, the switch that's shown right here is normally in the position where it connects the bleed controller the PI controller over here to the bleed valve.

When high flow condition exists, that switch moves up, and when it moves up — when it moves up, what it does is disconnect the PI controller from the bleed valve and substitutes a closed voltage equivalent to a closed position.

Closed to exhaust. That's what this voltage signal represents. And it is applied then instead of the P and I control signal.

Q: This other signal that is applied instead of the PI control signal, is it a PI control signal?

A: No, it's not. It's constant voltage.

Q: Let me ask you, I believe Mr. Muller may have said that switching so the PI signal is not used would adjust the magnitude of the PI control

Page 1390

signal. In your understanding, is that correct?

A: No, that's not correct. The PI control signal remains whatever it was before the switching took place. It is not affected at all by the switching.

Q: Thank you.

Mr. Shinskey, did you participate in preparing an animation that we've put together to try to illustrate just how inlet guide vane position is used and the effect of the high flow logic in the APS 3200?

A: I did.

Q: I'm going to ask if we could bring that up and if you could walk us through it.

A: Here we have a graphic of the compressor, the bleed valve at the top, and the bleed valve swings left to right to change the air flow from going to the aircraft to going to exhaust.

And we have superimposed on this the same double valued function that we've already seen.

Over to the left we have this box, this is the electronic control box and we've only shown it as outputs. It has many inputs, but more

Page 1391

simplicity we've only shown two of its outputs.

And one of the outputs, the line that you see that is blue with the yellow bars in it, this is the output of the P and I controller.

And this goes through a switch and then into the actuator that operates the bleed valve.

The green line to the left is the logical signal, the bleed select signal. And the bleed select signal has a value of zero or one. And in the normal condition when there is low flow, the value is zero and so it does not operate the switch.

However, when we reach the high flow cutoff you'll see the switch will move over to this constant voltage signal which is this green block at the top.

So what we're going to do is to follow the sequence of events as flow is increased based on demand from the aircraft.

Q: Should we make it run?

A: Yes, could you start it over again, please.

Now, you see the blade spinning on

Page 1392

the compressor and you will see air flow begin flowing first to exhaust assuming no demand from the aircraft.

Now, the demand from the aircraft is increasing and as it does the surge controller begins to close the valve for less exhaust.

Finally, when the aircraft has demanded enough air, the exhaust is closed and now you see that the flow is increasing, follow the black arrow on the inserted diagram you can see flow increasing above set point. As long as the flow remains above set point the bleed control valve is closed to exhaust.

Q: This is where we are before the system has even gotten to the high flow switch?

A: Yes, we're still in the low-flow mode, but the bleed valve is closed.

Now, as flow continues to increase, we will reach — follow the black ball, we will reach the high-flow cutoff and you will see the switch transferred us to high flow. Okay. Bleed select now has changed states.

Now we're in the high-flow mode and you can see that the bleed control valve is no

Page 1393

longer connected to the P and I controller. Now the P and I controller, still functions, it still produces whatever signal it produced before the transfer took place, but now the bleed control valve has a constant voltage which keeps it closed to exhaust.

Q: Mr. Shinskey, let me ask you, are the magnitudes of the PI signal any different now that the system is in high flow?

A: No, they're not different at all. They're simply not used.

Q: We saw the system switched into high flow, we talked about a test that used IGV position and a test that does not use IGV position. Which of those two switch the system into high flow?

A: The test that does not use IGV position.

Now, the flow continues and we can even go past the peak. Now we're going back down in load. You'll see the transfer takes place, we're back into the low-flow mode, still the bleed valve is closed to exhaust because the flow is still well above the set point. And as flow falls such that the DELPQP now approaches set point, the

Page 1394

bleed valve will open to maintain set point so that the DELPQP never falls down into the surge region.

If you can continue. And we can go all the way to zero load where all of the flow will then go to the exhaust without falling below set point.

Q: Would you like to run it once more just to briefly explain?

A: I'm happy to do that.

Q: Let me ask you, when the bleed valve is being moved at all, is that as a result of the system that adjusts the set point waived on temperature?

A: Yes, it is. If the temperature were to change, then the set point would change and that would of course cause the controller to move the bleed valve if the bleed valve were open and therefore controlling at set point.

Again, start off very little flow, all going to exhaust, the load to the aircraft begins to increase as the air conditioning system calls for air. The more air that flows, the less that needs to be exhausted.

Page 1395

The exhaust valve is closed, flow continues to increase, when the high-flow cutoff is reached, transfer takes place, disconnecting the P and I controller from the bleed valve and locking the valve closed to exhaust.

And the reverse happens when the flow decreases, transfer takes place, bleed valve remains closed because we're still above set point. Only as we approach set point does the bleed valve begin to open by the P and I controller.

Q: Thank you.

Mr. Shinskey, before we turn — you might want to have a seat.

Before we turn to comparing the APS 3200 to the Honeywell patent claims, looking at the system that we just saw, does the patent teach or disclose any kind of system like what we were just witnessing?

A: As far as the high flow —

Q: Exactly the high-flow logic?

A: No, there is nothing in the patent that describes switching between high flow and low flow or disconnecting the PI controller, the bleed valve.

Page 1396

Q: We talked about an engineer of ordinary skill in this field. Would such an engineer who read the patents be enabled or taught how to develop such a system?

A: No, there is no way.

Q: Why don't we turn to the patent claims and let's begin with the '194 patent.

If you could project 51 A. We're trying to have a projection of Claim 4 so it would be easier for all of us to follow along.

What we did have is a version of this without the nose on the right-hand side but that won't project, so with your Honor's indulgence we'll project it this way.

MR. PUTNAM: That's fine.

Q: Mr. Shinskey, let's begin with claim 4 of the '194 patent, and this is the only claim that Honeywell is asserting is literally infringed by the APS 3200. Why don't I read it first and then we'll talk about how these elements relate to the 3200.

Claim 4 states, "A method of utilizing a compressor of a gas turbine engine to power pneumatically operated apparatus having a

Page 1397

variable inlet air flow demand, the compressor having adjustable inlet guide vanes, said method comprising the steps of (a) interconnecting a supply duct between the compressor and the pneumatically-operated apparatus, (b) flowing discharge air from the compressor through said supply duct to pneumatically operated apparatus, (c) maintaining an essentially constant minimum supply duct flow rate, despite fluctuations in the flow rate of air received by the pneumatically-operated apparatus, by exhausting air from said supply duct in response to variations therein of the value of a predetermined, flow-related parameter, the flow rate of air exhausted from said supply duct being related to the magnitude of said parameter value variations in both a proportional and time-integral manner, said maintaining step including the steps of providing an outlet passage from said supply duct, positioning in said outlet passage a surge bleed valve operable to selectively vary the flow of air outward through said outlet passage, generating an integral control signal in response to said variation in

Page 1398

said flow-related parameter and simultaneously utilizing said integral and proportional control signals to operate said surge bleed valve; and (d) interrupting said integral control signal when the difference between the actual value of said parameter and a desired value thereof exceeds a predetermined level. Relationship between the magnitudes of said integral and proportional control signals and the magnitudes of said parameter variations as a function of the position of the inlet guide vanes.

Let me look first at element D. Again, this states, "Adjusting the relationship between the magnitudes of said integral and proportional control signals and the magnitudes of said parameter variations as a function of the position of the inlet guide vanes."

Mr. Shinskey, is this satisfied in the APS 3200?

A: No, it's not.

Q: Why don't we call up figure chart 30. If you could, please, explain in your understanding why this is not satisfied by the APS 3200?

A: Well, you can see that the P and I

Page 1399

controller operates at — has as an input the error signal A and the inputs through the comparator which produces the error signal are DELPQP and the surge set point which is derived as a function of temperature.

IGV position is not an input into the P and I controller and therefore IGV position has no way of affecting the controller output and therefore the relationship between the magnitudes after the controller output signals and any flow-related parameter.

Q: In the APS 3200, what, if anything, does adjust the relationship as specified in element D?

A: That relationship is a function of temperature.

Q: We talked about the effect of switching the system of the APS 3200 into high flow and low flow, does the adjust the relationship between the magnitudes of the integral and proportional signal and the magnitude of the inlet guide vane parameters?

A: No, it does not. The high flow switching takes place downstream of the P and I controller. It doesn't affect the output signals of the P and

Page 1400

I controller at all.

Q: Now, in your view, is what the APS 3200 does with IGV position in the high flow logic equivalent to what element D requires?

A: No, it's not equivalent at all.

Q: If you could please explain why you say that?

A: Well, the functions that are performed are entirely different. The function that is performed in the patent is to take the IGV position and adjust the set point of the controller so that the surge control, the flow representing surge conditions, or approach the surge control conditions is affected as a function of IGV, as the IGV position moves, the set point position moves.

In the case of the APS 3200, that role is taken by temperature. So there is no relationship there.

The way in which this is performed is by — through the act of adjusting the set point to the comparator

which then goes to the P and I controller and changes its output in the patent.

Page 1401

In the case of the APS 3200, IGV position has a completely different function. Its function is to lock out the P and I controller from even moving the bleed valve.

And the way in which it does it is to — through the bleed select logic is to throw a switch disconnecting the P and I controller.

And finally the results are completely different. The result of the use of IGV position in the patent is to be sure that the surge controller operate at a safe set point at all conditions of IGV position, whereas in the — the result in the case of the APS 3200, is to insure that when we are an in the high flow condition, the surge controller, the P and I controller does not operate the bleed valve. So all three are different.

Q: Now, I believe Mr. Muller in going through this analysis may have said something to the effect that all the patent requires is that inlet guide vane position be used in some way in a surge control system. In your understanding, is that a fair reading of element D?

A: No, that's not a fair reading at all.

Page 1402

Q: Can you please explain?

MR. PUTNAM: Objection Your Honor it's calling for claim construction testimony. The question was a fair reading of claim D.

THE COURT: Let me see counsel at side-bar.

(Side-bar conference.)

THE COURT: Go ahead, Mr. Putnam.

MR. PUTNAM: The question is asking the witness to interpret what claim D means. That is not proper testimony in front of the jury. As the Court knows, it's an issue for the Court. I don't need to remind the Court of the history on this topic. I know that's pending before the Court, but in any event, it's not proper and the witness cannot testify as to meaning of claim D, he can testify to what he thinks it satisfies.

When he testifies to the meaning, he's suggesting the claim construction to the jury and that's Your Honor's duty to instruct the jury on.

MR. HERRINGTON: First of all, it's hard to talk about the claims without asking questions like this. I think I might be able to

Page 1403

cure this by saying what is the function of the claim D and that's certainly something we can ask an expert to come in and relate in an engineering way when he thinks the function is.

MR. PUTNAM: Well, the pending question was what the meaning of the claim. He can talk about the function.

THE COURT: Then I'll sustain the objection. Go ahead.

MR. HERRINGTON: Okay.

THE COURT: Did you want to say something else?

MR. HERRINGTON: I'm, I think we can get to the same question about the comparator and use the claims, and again I think it will just be what is a comparator, what's the function of a comparator.

MR. PUTNAM: And my objection is to any testimony that ask him here is a claim term, what does that term mean in your understanding.

THE COURT: Okay.

MR. PUTNAM: I think that's the objection.

THE COURT: And I understand the

Page 1404

objection and it is sustained.

MR. PUTNAM: Thank you, Your Honor.

(End of side-bar conference.)

THE COURT: Mr. Herrington, you're going to rephrase the question?

MR. HERRINGTON: Sure.

BY MR. HERRINGTON:

Q: Mr. Shinskey, looking at element D, in your view is it fair to say that the function of what's called for there is merely to use inlet guide vane position in some way in a surge control system?

MR. PUTNAM: Objection.

THE COURT: Sustained, that's a little leading, Mr. Herrington.

MR. HERRINGTON: Okay.

BY MR. HERRINGTON:

Q: Mr. Shinskey, looking at element D, what do you understand the function of that element to require?

A: I understand that the function of that element is to move, adjust the magnitudes of the controller output signals which are operating the bleed valve as the inlet guide vane position

Page 1405

moves.

Q: And again, is that function carried out by the APS 3200?

A: No, it's not. In fact, the use of the inlet guide vane position in the APS 3200 has really nothing to do with surge control because it represents a high flow condition where there is no danger of surge whatsoever.

Q: Thank you.

Let's look at another part of Claim 4, and that's the last phrase in element C. And again, that states, element C refers to generating integral and proportional control signals and then it states in the last phrase, "utilizing said integral and proportional control signals to operate said surge bleed valve".

Let me ask you, Mr. Shinskey, when the APS 3200 does switch into high flow, is what we have just read satisfied?

A: No, it's not. The integral and proportional control signals are disconnected from the surge bleed valve.

Q: Let's look further up in element C. It refers to — why don't I read again from element

Page 1406

C, and I'll tell you the language I would like to you focus on.

Element C states "maintaining an essentially constant minimum supply duct flow rate, despite fluctuations in the flow rate of air received by the pneumatically-operated apparatus, by exhausting air from said supply duct in response to variation therein of the value of a predetermined flow-related parameter."

Is that reference to the value of a predetermined flow-related parameter measured in the supply duct present in the APS 3200?

A: No. The APS 3200 does not measure the flow rate in the supply duct. It's a different type of measurement. It's measured across the diffuser in the compressor itself.

Q: And is the measurement that the APS 3200 takes or the variable that the APS 3200 measures, is that the same as or equivalent to what's being described here in element C?

A: No, its not simply a flow-related parameter. It has a very strong component of compression ratio in its output.

Q: How does the performance of the variable,

Page 1407

as measured by the APS 3200, compare to what you would understand as a predetermined — as a flow-related parameter that's measured in a supply duct?

A: Well, if the use of a flow-related parameter measured in the supply duct requires the adjustment of a set point of the surge controller as a function of guide vane position, if we wish to control close to surge conditions, whereas the use of the DELPQP signal as our surge variable for the APS 3200 appears to be insensitive to variations in the position of the inlet guide vanes and therefore the inlet guide vane signal is not used to adjust the set point for the surge controller in the APS 3200.

Q: Before you move on from Claim 4, I just want to clarify what we're talking about in element C is the difference between APS 3200 and the required by Claim 4, is that a straight and distinct difference from what you discussed with respect to element D of Claim 4?

A: If I understand the question correctly, I believe that claim C and claim D must both apply at the same time, or excuse me, element C and

Page 1408

element D must both apply at the same time, they're not one or the other.

Q: I guess just to clarify, what you've identified as addressing Claim 4 as it applies in the APS 3200 is there are at least two differences between the APS 3200 and what's required in Claim 4?

MR. PUTNAM: Objection.

MR. HERRINGTON: I'm just sort of summarizing his testimony, Your Honor.

THE COURT: Why don't instead of summarizing the testimony, put the next question out to the witness.

MR. HERRINGTON: Okay. BY MR. HERRINGTON:

Q: Mr. Shinskey, again, what you have stated here, how many differences are there between what Claim 4 requires and what the APS 3200 does?

A: Well, the difference in the flow-related parameter, as I said DELPQP is not a flow-related parameter, and secondly, there is the element D of the Claim 4 is completely absent in the APS 3200.

Q: Thank you.

Now, why don't we turn to item eight

Page 1409

of the '893 patent, that's going to be chart 55. And Mr. Shinskey, the '893 patent is Defendant's Exhibit No. 2. I believe you have that there with you?

A: Yes, I have.

Q: Let me read Claim 8 and then we'll focus in on some of the elements. It states, "A gas turbine engine accessory power unit having a fluctuating compressed air supply demand, said accessory power unit comprising: (a) a compressor having adjustable inlet guide vanes; (b) duct means for receiving compressed air discharged from said compressor and supplying the received air to the pneumatically-powered apparatus; (c) surge bleed means operable to exhaust from said duct means a selectively variable quantity of air to assure at least a predetermined minimum flow rate through said duct means and thereby prevent surge of said compressor; (d) sensing means for sensing the value of a predetermined, flow-related parameter within said duct means and generating an output signal indicative of said value, said value of said flow-rated parameter being substantially independent of the temperature of the compressed

Page 1410

air; (e) comparator means for receiving said sensing means output signal and generating an error signal representing the difference between the sensed value of said parameter and a desired value thereof, said comparator means having an adjustable control set point representing said desired value of said parameter."

Mr. Shinskey, I'm going to ask you about the next element, but why don't we stop at element E and talk about whether the APS 3200 does have a comparator that has an adjustable control set point.

A: Was that a question?

Q: Yes.

A: The APS 3200 does have a comparator with an adjustable control set point, yes. And that's set point does represent the desired value.

Q: Can you show chart 32.

Mr. Shinskey, if you could, please, identify what we have here?

A: We have a comparator, which is this circle right here. One input into the comparator is the set point. And the other input to the comparator is the surge control variable, which in

Page 1411

the case of the APS 3200 is DELPQP.

Q: We'll go back to Claim 8. Now — chart 55.

Now, let's focus on this next element of Claim 8, that's element F, and it states, "Means for transmitting to said comparator means a reset signal for varying said set point as a function of the position of said inlet guide vanes in accordance with a predetermined reset schedule."

Mr. Shinskey, is that element present in the APS 3200?

A: No, it's not. There is no connection between the position of the guide vanes and the comparator in the APS 3200.

Q: Is what the APS 3200 does with inlet guide vane position the equivalent of what element F requires?

A: No, it does not.

Q: Could you explain why that is so?

A: Well, element F requires the use of the guide vane position signal to reset the set point of the surge controller, according to a schedule, and that is simply not done in the APS 3200.

Page 1412

Q: Now, I believe Mr. Muller in his testimony that element F was satisfied in the APS 3200 pointed to something different than a comparator that you referred to when you were looking at element E.

In your understanding, is what he pointed to something, that place, the same function as what's required by element E and F?

A: No. In fact, element F requires the means for transmitting the reset signal to said comparator, which means it has to be the same comparator described in element E.

And Mr. Muller pointed to a different comparator on a different diagram. In fact, the device which he identified as the second comparator was the or gate, it's not a comparator at all.

Q: Looking at element F, what in your understanding is the function of that element as required by Claim 8?

A: The function of element F is to adjust the set point of the surge controller as the inlet guide vanes in the aircraft, in the compressor are moved.

Page 1413

Q: And is that function performed by inlet guide vane position as used in the APS 3200?

A: No, in the APS 3200 the function of inlet guide vanes is to disconnect the PI controller — excuse me, is to maintain high flow and keep the controller disconnected from the bleed valve.

Q: If you could, please, compare what element F requires and what the APS 3200 does in terms of the way they operate and the result of how they operate?

A: The way in which the surge controller in the patent operates is to have set point of the flow related